UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF HOME ECONOMICS
Washington, D. C.

METHODS OF CHECKING PRESSURE CANNER GAGES

Scientific studies show that nonacid vegetables and meat must be processed at temperatures above boiling if certain strains of bacteria almost universally present are to be destroyed. The pressure canner used for processing these products is ordinarily equipped with a pressure gage but not with a thermometer. In that case the only guide to the temperature reached inside the retort is the pressure gage reading. For this reason, and because satisfactory processing is based on time and temperature, it is important that pressure gages register accurately. If the pressure gage is inaccurate and the canner is not equipped with a thermometer, there is no measure of the temperature in the retort. If the variations in the pressure reading are such as to make the temperatures too low there is danger of insufficient processing and spoilage If the temperature is too high there is the possibility of lowering the quality of the product from overprocessing.

Some simple way of checking pressure canner gages is obviously greatly needed. This mimeograph suggests three ways of checking.

METHOD I. - With a Maximum Thermometer

Maximum thermometers of suitable range, 100° to 300°F., or 85° to 135°C., may be obtained from companies selling scientific equipment for $3.25 to $4.50, depending on the size and divisions of the scale.

Before using the thermometer for testing pressure gages, have it checked in an oil bath at 227°, 239°, and 250°F., using a thermometer from an experimental laboratory that has been checked at the above temperatures. Record the deviations of the test thermometer at each of these three temperatures. If the deviation amounts to 1° or more, correct the thermometer readings obtained in the tests accordingly.

Manufacturers advise that dropping the thermometer so that it strikes sidewise sometimes divides the mercury column, causing the instrument to register incorrectly. Rough handling in the mails is frequently responsible for dividing the mercury in an instrument after it leaves the factory. To correct this condition, chill the mercury-well in a bowl of cracked ice or ice and salt. Shake down the mercury and repeat as often as necessary.

Making the test:

1. Start the test by placing one-half inch of water in the bottom of the canner.

2. Suspend the thermometer by a string between the handles of the wire basket that comes with the canner. This will permit the steam to circulate freely around the thermometer.

3. Exhaust the canner. This is to prevent the formation of an air pocket under the cover. The exhaust period for canners up to 30 quarts capacity must be a full 7 minutes after an active flow of live steam begins to issue from the petcock. For canners of over 30 quarts 10 minutes is required.

4. After exhausting, close the petcock. Run the pressure up slowly, taking at least 10 minutes. When pressure is near the desired point, tap the gage lightly. If the gage has been handled carelessly or if there are mechanical irregularities within the gage the pointer may not advance uniformly with increasing temperature. Instead, it will remain stationary for some time and then jump ahead.

5. Make the check as near the desired pressure as the pointer can be held practically steady for 3 minutes. There is a short lag (perhaps only a few seconds) before the thermometer reading will correspond with the temperature of the steam in the canner.

6. Loosen the petcock to release the steam. When the pointer of the gage returns to zero, open the canner.

7. Take out the thermometer without jarring it or striking it against anything. Even a slight jar may drive enough of the mercury back into the bulb to affect the reading. In reading the thermometer hold it level with the eyes as it is easy to introduce error at this point.

8. Record in the proper column of a form similar to the one shown on page 10 of this mimeograph the thermometer reading corresponding to the pressure. Then shake down the mercury to 220°F or below and repeat.

9. Figure actual deviations in gage pressure as follows:

(a) From the expected (correct) thermometer reading at sea level, subtract the reading observed. (Expected readings at sea level are 227°F. at 5 pounds, 239°F. at 10 pounds, 250°F. at 15 pounds pressure per square inch).

(b) At sea level each additional pound of pressure causes an increase of 2° in temperature. Therefore the number of degrees difference between the expected and the observed temperatures will be twice the number of pounds deviation in the pressure gage.

(c) If the observed temperature is lower than expected temperature, the gage is registering too high, or has a plus deviation. If the observed temperature is higher than the expected temperature, the gage is registering too low, or has a minus deviatio

(d) Correct this apparent deviation for altitude at the place of test as follows: Round the feet above sea level to the nearest 1,000 feet, and decrease plus deviations by .5 pound, for each 1,000 feet. Increase minus deviations by the same amount Table 1 shows the approximate equivalents for temperature and steam pressure at different altitudes.

Table 1. - Approximate equivalents for temperature and steam pressure at different altitudes

Altitude	Steam Pressure required to give 239°F.	Steam pressure required to give 250°F.
Feet above sea level	Pounds	Pounds
1,000	10.0	15.0
2,000	10.5	15.5
3,000	11.0	16.0
4,000	11.5	16.5
5,000	12.0	17.0
6,000	12.5	17.5
7,000	13.0	18.0
8,000	13.5	18.5
9,000	14.0	19.0
10,000	14.5	19.5

Example showing how to figure gage deviations at 2,600 feet:

(a) Round altitude to 3,000 feet.

(b) Correction for altitude, 1.5 pounds per square inch.

(c) Expected reading at 10 pounds (sea level) 239°F.
Observed reading at 10 pounds 233°F.
Difference in readings - 6°F.
Apparent deviation in gage pressure +3.0 pounds per square inch
Correction for altitude -1.5 pounds per square inch
Corredted deviation +1.5 pounds per square inch

(d) Expected reading at 10 pounds (sea level) 239°F.
Observed reading at 10 pounds 243°F.
Difference in readings +4°F.
Apparent deviation in gage pressure -2 pounds per square inch
Correction for altitude -1.5 pounds per square inch
Corrected deviation -3.5 pounds per square inch

10. If corrected gage deviation is more than 2 pounds, advise the owner to get a new gage. If deviation is 2 pounds, or less, tag the canner with the number of pounds the gage must read to produce 5, 10, and 15 pounds per square inch pressure respectively at the prevailing altitude.

METHOD II. - With a retort Thermometer

A simple, rapid way to make the same test is to fit one or more canners with retort thermometers as directed below.

A 5-inch straight stem mercury retort thermometer registering from 170° to 270°F. may be purchased for about $5.00. This thermometer is furnished with a standard iron pipe size (IPS) one-fourth inch or larger male thread. The usual attachments on pressure canners have one-eighth inch male threads.

To set a retort thermometer into the cover of a pressure canner, have a plumber or a machinist drill and tap a hole in the canner cover for a suitable thread. If space on the pressure canner cover permits, two or three places may be drilled and tapped with one-eighth inch threads for setting gages so that a multiple of tests can be made at one time. When not in use an opening may be closed by a suitable plug. Reserve this canner exclusively for testing purposes.

Making the Test:

1. In using a canner with a permanently set retort thermometer screw the gage to be tested into the canner cover. This operation requires a wrench or pliers to grip the flat surface of the attachment. It also requires a strong right arm.

2. Exhaust the canner for 7 minutes to remove all air before running up the pressure. Bring the retort thermometer to the temperature desired (227°, 239°, or 250°F.) and hold it steady for a couple of minutes. In appropriate columns on a form similar to the second example on page 10 record the pressure shown by the gage or gages being tested.

3. To correct the gage reading for altitude, reduce plus deviations by .5 pound and increase minus deviations by the same amount for each 1,000 feet of altitude above sea level. (See table 1, page 3). Then compare the corrected gage reading with the expected sea level reading. The difference will be the plus or minus deviation of the gage being tested. (See example on page 3).

METHOD III. - Using a Manometer with Air Pressure

The photograph on page 11 shows an apparatus 1/ for the multiple checking of pressure canner gages using a mercury manometer. The apparatus is quite easy to assemble and to operate, and with it several pressure gages can be tested at one time.

The apparatus is made from the following parts: a mercury manometer; a number of short lengths of one-fourth inch standard iron pipe size (IPS) brass pipe and fittings including a supply of one-fourth inch and one-eighth inch brass plugs; 1 or 2 Mueller three-eighths inch brass laboratory hosecocks; 2 lengths of flexible copper tubing (three-eighths inch outside diameter); 2 flare half-unions; a 1 to 2-pint bottle fitted with a one-hole rubber stopper; and a hand air pump with a valve on the delivery nozzle. A football pump has such a val-

1/ Homer J. Dana, assistant director, Engineering Experiment Station, Pullman, Wash., prepared the original design for this apparatus, which used city water pressure instead of air pressure.

Total height of the apparatus should be such that the gages will be at eye level for a person of average height. Eye level for the average person is approximately 58 inches.

The mercury manometer consists of a U-tube of heavy glass (Pyrex glass is recommended) at least 40 inches long mounted on a wooden upright support, which rests upon a substantial cast-iron base. One end of the glass U-tube is open. The other is bent horizontally and connected by means of a short section of rubber pressure tubing to a length of flexible copper tubing. This, in turn, is joined to the rest of the piping by means of a flare half-union. The flare half-unions and the flexible copper tubing may be obtained from any automobile or mechanical refrigerator service man. Have the vendor flare one end of each piece of tubing and bend to proper shape. The pressure side of the manometer may be either its right or left side. This description has been prepared for a manometer with pressure applied on the left-hand side.

The measuring stick set inside of the loop of the U-tube may be the meter stick usually furnished with such manometers. This is graduated to millimeters on both edges of one side. The other side of the stick is usually graduated in inches to eighths on one edge only. To make the measurements in inches rather than centimeters, use this side of the stick and take readings by placing a straight edge (white card or ruler) across from the graduations to the mercury column.

Prepare a new manometer for use by rinsing out the glass U-tube with distilled water, then alcohol. Allow to dry. If the manometer has been used before, rinse out the U-tube first with aqua regia. Follow with distilled water, then alcohol.

Use only new, clean mercury in the manometer. Pour it into the U-tube through a glass funnel with a very small opening, and add enough to fill the U-tube a little over half full. Keep watches, rings, and other articles of gold or silver away from mercury.

A single large laboratory hosecock (brass, three-eighths inch size) may serve both as an inlet and holding valve, and also as a relief valve for reducing excess pressure. Remove the small screw just below the handle to permit the handle to swing entirely around. Then with the handle of the hosecock parallel with the nozzle drill a small hole through one side and halfway through the core of the valve using a No. 54 or smaller twist drill. When the handle of the hosecock is turned to the open or inlet position, air from the hand pump will go through the hosecock to the gages and manometer. A quarter turn of the handle confines the air in the gages and manometer, while another quarter turn brings the relief port into position to reduce the pressure. Or any good valve may be used as an inlet from the pump, and a similar valve may be attached to one of the T's as a relief valve. In any case the valves used must be airtight.

The purpose of the pressure bottle is to furnish a reservoir for the air. This reservoir helps to keep the mercury from blosing out of the open end of the manometer. It also minimizes the effect of very tiny leaks. Shellac liberally the inside of bottle neck, inside and outside of stopper, and outside of copper tubing. Tie stopper in the bottle firmly.

Assemble the sections of brass pipe, or nipples, hosecock, bottle and hand pump in the order shown in the illustration on Page 11. To make the joint airtight place a liberal coating of orange shellac on the threads of any sections that are to be joined, except the flare half-unions and their nuts. Then screw tightly into place. Allow the shellac to dry. Tools needed in assembling the different parts of the apparatus include a screw driver, a 6 or 8-inch stillson wrench, a 6 or 8-inch monkey wrench, and a thin open-end wrench

To determine whether or not the apparatus is in working order, set the handle of the hosecock to the inlet position and gently operate the pump. Continue pumping until the mercury level in the right-hand arm of the manometer reaches about 2 inches (5 cm.) from the top of the tube. Then hold the handle of the pump all of the way in with one hand. With the other hand quickly turn the handle of the valve to the holding position. If the apparatus is tight, the level of mercury in the two arms of the U-tube will settle a bit and then maintain a certain difference of level for some time. If there are any air leaks the difference in level of mercury in the two arms will decrease. The apparatus must be airtight or practically so.

Places of leakage of air may be discovered by making a stiff lather with soap and water and applying it to each joint while the air pressure is as high as possible. Soap bubbles will be formed at the points of leakage. If the leak is too small to be found with soap and water, loosen the clamps that hold the pipe and remove the entire apparatus, still attached to the manometer, from its bench, and place it in a large pan or tub of water.

If this cannot be conveniently done, immerse one end of the pipe at a time. Avoid placing undue strain on the glass U-tube. Bubbles of escaping air will show the location of any leaks in the brass pipe or fittings just as would be the case with an inner tube with a small leak. The leaking joints must be taken apart, more shellac applied, and the parts put together tightly again. After the shellac sets, apply pressure again, and retest until the apparatus is tight.

If the pump fails to deliver the required pressure, clean the inside of the barrel of the pump and insert a few drops of medium-thick automobile oil. A new leather will be needed on the pump occasionally.

If a pressure canner gage is tested at room temperature with this apparatus and then used under steam pressure at 250°F., a correction for temperature is required. Under such circumstances gages that are in good condition will register about one-half pound higher than the indicated pressure at room temperature.

Making the test:

1. Set the handle of the hosecock in the inlet position.

2. Operate the air pump cautiously until the mercury in the open arm of the U-tube is about 2 inches (5 cm.) from the top of the tube. Hold the handle of the pump all of the way in with one hand. With the other hand quickly turn the handle of the hosecock one-fourth turn to the holding position

3. Read and record on form similar to the one shown on page 9 the height of the mercury columns to the nearest one-tenth centimeter, or one-sixteenth inch. While taking the readings have the eyes on a level with the top of the mercury and place a straight edge (white card or ruler) across from the top of the curved line or meniscus of the mercury to the measuring stick.

4. With the eyes on a level with the instruments read and record the pressure indicated by each gage under test. It is good practice to tap the gages gently 2 or 3 times before reading.

5. (a) If the scale of the measuring stick is graduated in centimeters, determine the difference between the readings taken from the two arms of the U-tube. Refer this number to table 2, page 8, and select the nearest corresponding "correct pressure at the gage".

(b) If the scale of the measuring stick is graduated in inches to eighths, determine the difference between the readings taken from the two arms of the U-tube. Reduce any fraction to the nearest tenth. Refer this number to table 2 and obtain the corresponding "correct pressure at the gage".

6. Make the same correction for altitude as described on page 3.

7. Record correct and observed "pressures at the gage" on a form simil to the third example on page 10.

Example showing how to figure correction for gage from manometer readings:

Right-hand manometer reading	92.4 cm.
Left-hand manometer reading	10.2 cm.
Observed pressure at gage	14.5 pounds per square inch
Right-hand reading minus left	82.2 cm.
Nearest figure in table 2	82.0 cm.
Correct pressure at gage	15.8 pounds per square inch
Observed pressure at gage	14.5 pounds per square inch
Correction for gage	+1.3 pounds per square inch

Table 2, page 8 is a table for reference when using the manometer.

TABLE 2. - Relation between pressure and the difference in level of mercury in the two arms of the manometer

Difference in level of mercury	Correct pressure at the gage	Difference in level of mercury	Difference in level of mercury	Correct pressure at the gage	Difference in level of mercury	Difference in level of mercury	Correct pressure at the gage	Difference in level of mercury
inches	pounds per square inch	centimeters	inches	pounds per square inch	centimeters	inches	pounds per square inch	centimeters
19.0	9.3	48.5	26.6	13.0	67.5	34.0	16.6	86.0
19.2	9.4	49.0	26.8	13.1	68.0	34.2	16.7	86.5
19.4	9.5	49.5	27.0	13.2	68.5	34.4	16.8	87.0
19.6	9.6	50.0	27.2	13.3	69.0	----	16.9-	87.5
19.8	9.7	50.5	27.4	13.4	69.5	34.6	16.9+	88.0
20.0	9.8	51.0	27.6	13.5	70.0	34.8	17.0	88.5
20.2	9.9	51.5	27.8	13.6	70.5	35.0	17.1	89.0
20.4	10.0	52.0	28.0	13.7	71.0	35.2	17.2	89.5
20.6	10.1	52.5	28.2	13.8	71.5	35.4	17.3	90.0
20.8	10.2	53.0	28.4	13.9	72.0	35.6	17.4	90.5
21.0	10.3	53.5	28.6	14.0	72.5	35.8	17.5	91.0
21.2	10.4	54.0	28.8	14.1	73.0	36.0	17.6	91.5
21.4	10.5	54.5	29.0	14.2	73.5	36.2	17.7	92.0
21.6	10.6	55.0	29.2	14.3-	74.0	36.4	17.8	92.5
21.8	10.7	55.5	----	14.3+	74.5	36.6	17.9	93.0
22.0	10.8	56.0	29.4	14.4	75.0	36.8	18.0	93.5
22.2	10.9	56.5	29.6	14.5	75.5	37.0	18.1	94.0
22.4	11.0	57.0	29.8	14.6	76.0	37.2	18.2	94.5
22.6	11.1	57.5	30.0	14.7	76.5	37.4	18.3	95.0
22.8	11.2	58.0	30.2	14.8	77.0	37.6	18.4	95.5
23.0	11.3	58.5	30.4	14.9	77.5	37.8	18.5	96.0
23.2	11.4-	59.0	30.6	15.0	78.0	38.0	18.6	96.5
23.4	11.4+	----	30.8	15.1	78.5	38.2	18.7	97.0
23.6	11.5	59.5	31.0	15.2	79.0	38.4	18.8	97.5
23.8	11.6	60.0	31.2	15.3	79.5	38.6	18.9	98.0
----	11.7-	60.5	31.4	15.4	80.0	38.8	19.0	98.5
24.0	11.7+	61.0	31.6	15.5	80.5	39.0	19.1	99.0
24.2	11.8	61.5	31.8	15.6	81.0	39.2	19.2	99.5
24.4	11.9	62.0	32.0	15.7	81.5	39.4	19.3	100.0
24.6	12.0	62.5	32.2	15.8	82.0	39.6	19.4	100.5
24.8	12.1	63.0	32.4	15.9	82.5	39.8	19.5-	101.0
25.0	12.2	63.5	32.6	16.0-	83.0	----	19.5+	101.5
25.2	12.3	64.0	32.8	16.0+	----	40.0	19.6	102.0
25.4	12.4	64.5	33.0	16.1	83.5	40.2	19.7	102.5
25.6	12.5	65.0	33.2	16.2	84.0	40.4	19.8	103.0
25.8	12.6	65.5	33.4	16.3	84.5	40.6	19.9	103.5
26.0	12.7	66.0	33.6	16.4	85.0	40.8	20.0	104.0
26.2	12.8	66.5	33.8	16.5	85.5	41.0	20.1	104.5
26.4	12.9	67.0	34.0	16.6	86.0	41.2	20.2	105.0
26.6	13.0	67.5						

Readings Taken on Manometer and Gage

Date	Gage number	Manometer readings			Observed pressure at gage	Correct gage pressure 1/	Difference between correct and observed pressur
		Right	Left	Right minus left			
		cn.	cm.	cm.	Pounds per sq. inch	Pounds per sq. inch	Pounds per sq. inch

1/ Correct gage pressure is obtained by subtracting the reading for the left arm of manometer from the reading for the right arm of manometer and referring the figure obtained to table 2.

RECORD OF PRESSURE CANNER GAGE TEST
Using Maximum Thermometer Inside Canner

State_____City_____County_____Altitude_____

Make of canner	Model number if any	Size	Age	Temperatures observed following readings on gage under test		Correction for gage	
				10 pounds per sq.in.	15 pounds per sq.in.	10 pounds per sq.in.	15 pounds per sq. in.

Using a Retort Thermometer on the Canner

Make of canner	Model number if any	Size	Age	Pressures observed on gage under test at following temperatures		Correction for gage (Pounds)	
				239°F.	250°F.	239°F.	250°F.

Using a Mercury Manometer with Air Pressure
at Room Temperature

Make of canner	Model number if any	Size	Age	Gage Pressure		
				Observed	Correct	Correction

Date_____Name of tester_____

MCS:SC:MB

Apparatus for multiple checking of pressure canner gages using mercury manometer: 1, Mercury manometer and stand; 2, support for gages and accessories; 3, hand-operated football air pump with valve; 4, soft rubber pressure tubing; 5, Mueller three-eighths inch laboratory hosecock with reducing bushing three-eighths inch to one-fourth inch; 6, standard iron pipe size one-fourth inch brass nipple one and one-half inches overall; 7, one-fourth inch brass nipple three and one-half inches overall; 8, one-fourth inch brass T; 9, one-fourth inch pipe clamp; 10, piece of copper tubing, three-eighths inch outside diameter, joined to a flare half-union; 11, pressure bottle, 1 to 2 pints, with one-hole rubber stopper; 12, canner gages under test; 13, one-eighth inch brass plug inserted in a reducing bushing one-fourth inch to one-eighth inch.